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1/77

21JUN02 E727391-4 D01559
P01/7700 0.00-0214231.3

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2. Patent application number *(The Patent Office will fill in this part)* — 0214231.3

3. Full name, address and postcode of the or of each applicant *(underline all surnames)*

   Albert Armer
   66 Gretton Road
   Winchcombe
   Cheltenham
   Gloucestershire
   GL54 5EL

   Timothy John Moffatt Armer
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   Winchcombe
   Cheltenham
   Gloucestershire
   GL54 5EL

   Patents ADP number *(if you know it)*

   If the applicant is a corporate body, give the country/state of its incorporation

   8408197001   8408205001

4. Title of the invention

   Pump Apparatus

5. Name of your agent *(if you have one)* — Wynne-Jones, Laine & James

   "Address for service" in the United Kingdom to which all correspondence should be sent *(including the postcode)*

   22 Rodney Road
   Cheltenham
   Glos GL50 1JJ
   United Kingdom

   Patents ADP number *(if you know it)* — 1792001

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Country	Priority application number *(if you know it)*	Date of filing *(day / month / year)*
--		

7. If this application is divided or otherwise derived from an earlier UK application, give the number and the filing date of the earlier application

Number of earlier application	Date of filing *(day / month / year)*
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8. Is a statement of inventorship and of right to grant of a patent required in support of this request? *(Answer 'Yes' if:*
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   b) there is an inventor who is not named as an applicant, or
   c) any named applicant is a corporate body.
   See note (d))

   No

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Claim(s)	–
Abstract	–
Drawing(s)	6 +6

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Translations of priority documents	–
Statement of inventorship and right to grant of a patent *(Patents Form 7/77)*	–
Request for preliminary examination and search *(Patents Form 9/77)*	–
Request for substantive examination *(Patents Form 10/77)*	–
Any other documents *(please specify)*	–

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Signature	Date
Wynne-Jones, Laine & James	19 June 2002

12. Name and daytime telephone number of person to contact in the United Kingdom — Mr B K C Dunlop — 01242 515807

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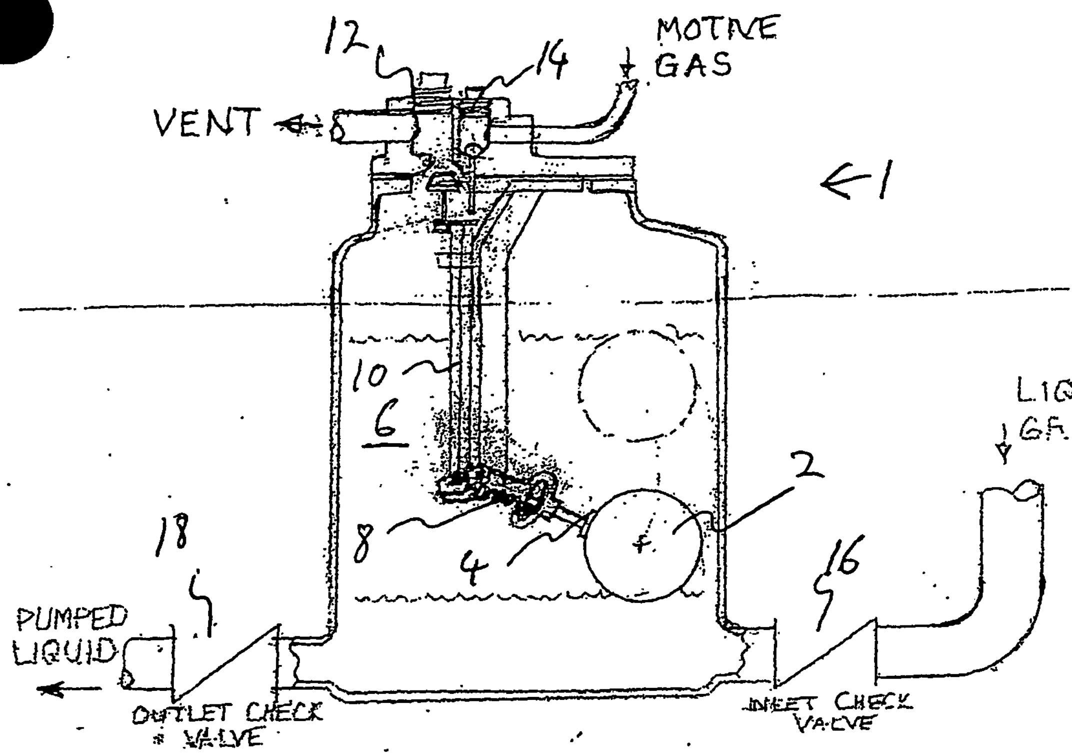

FIG. 1

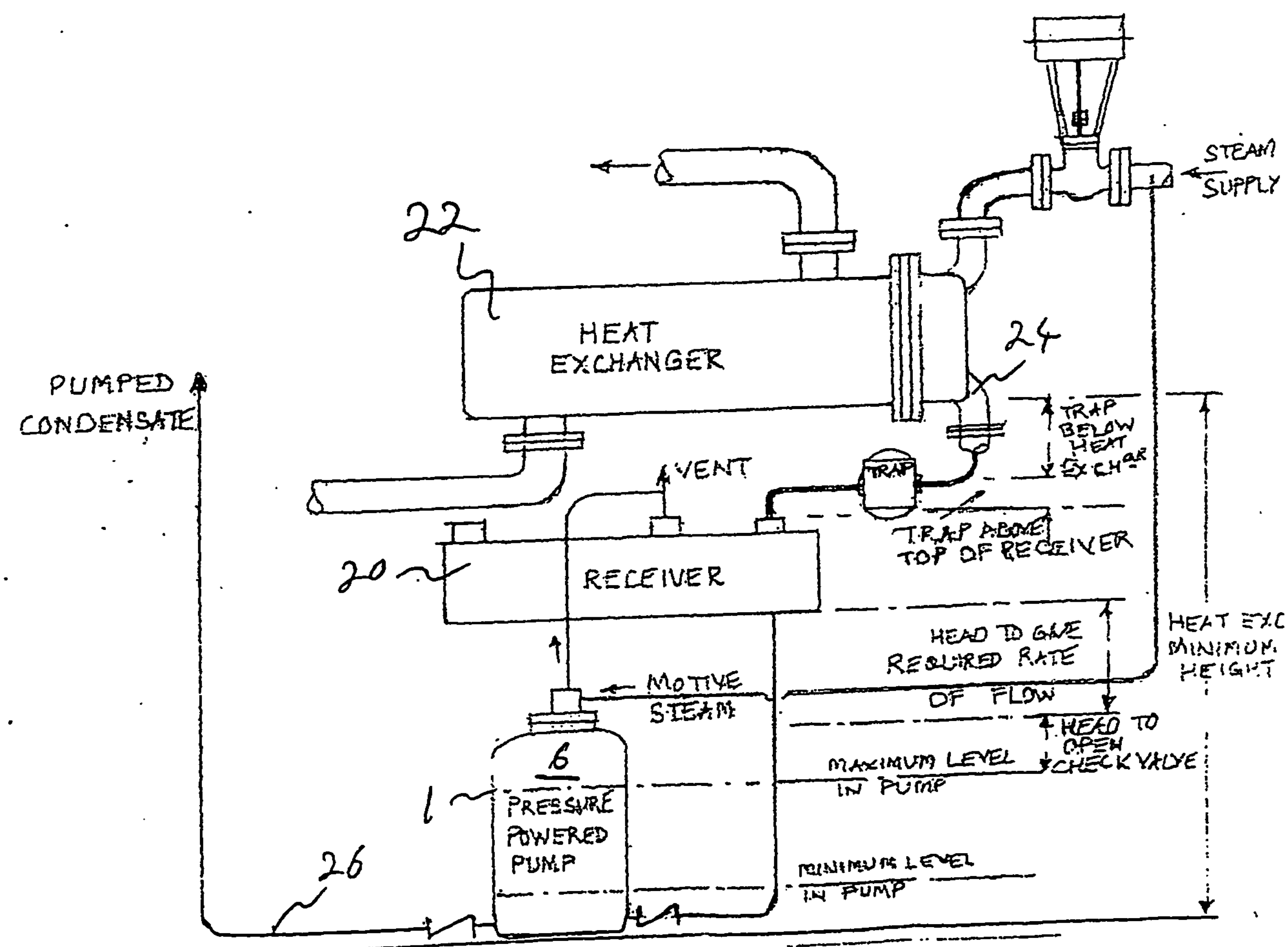

FIGURE 2.

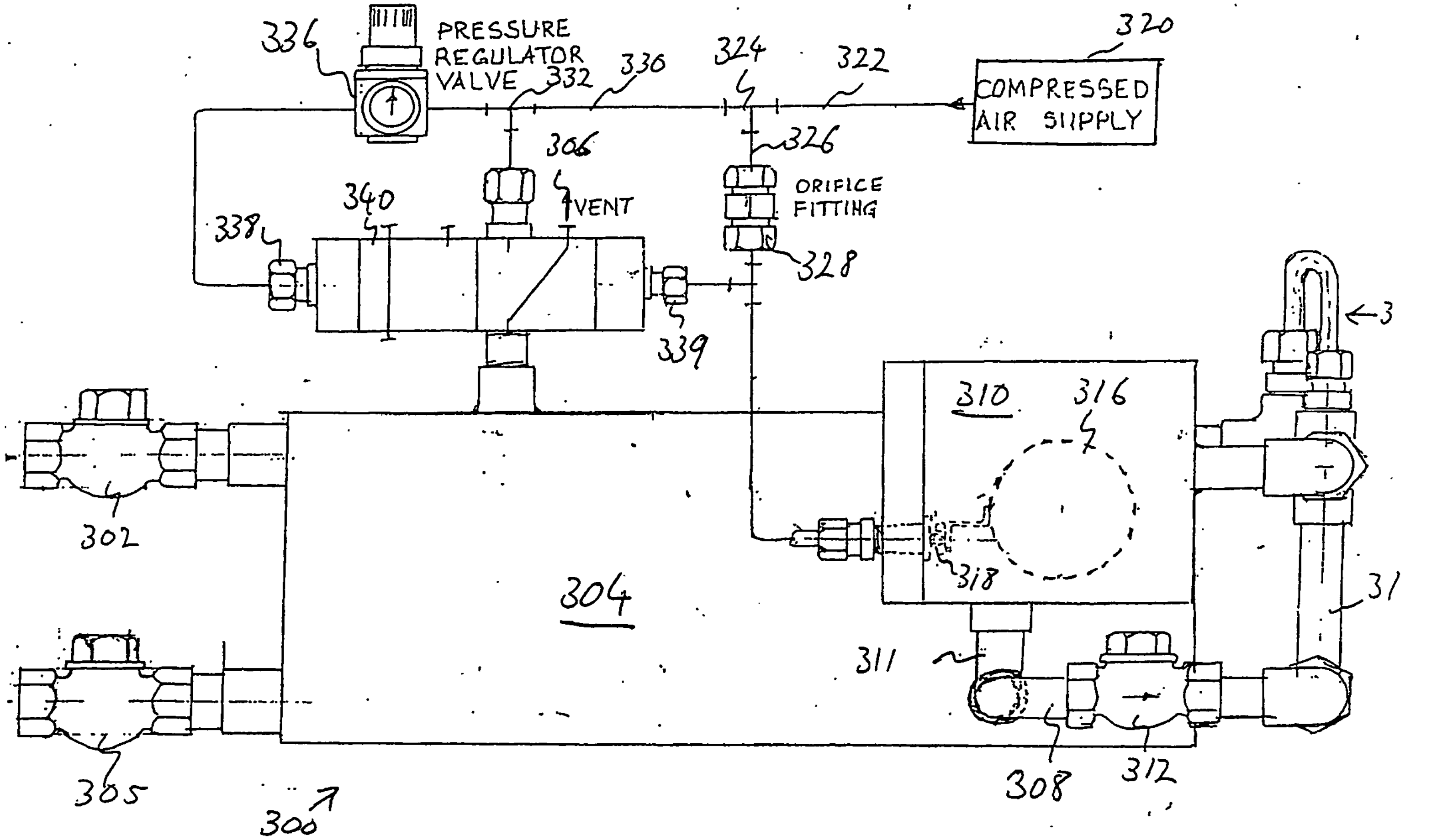
336
PRESSURE
REGULATOR
VALVE
332
330
324
322
320
COMPRESSED
AIR SUPPLY
306
326
VENT
ORIFICE
FITTING
340
338
328
339
3
310
316
302
304
318
31
311
305
308
312
300

FIG.3

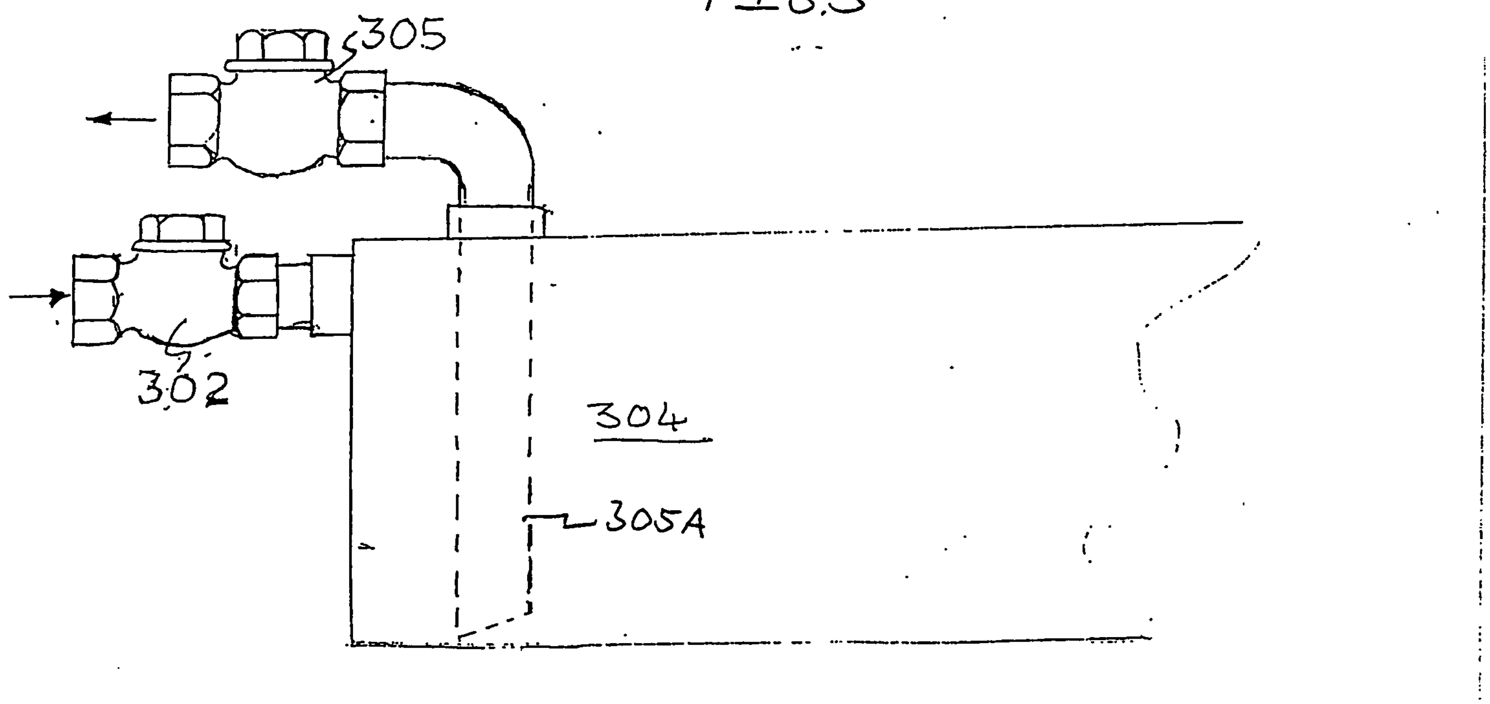
305
302
304
305A

FIG.2A

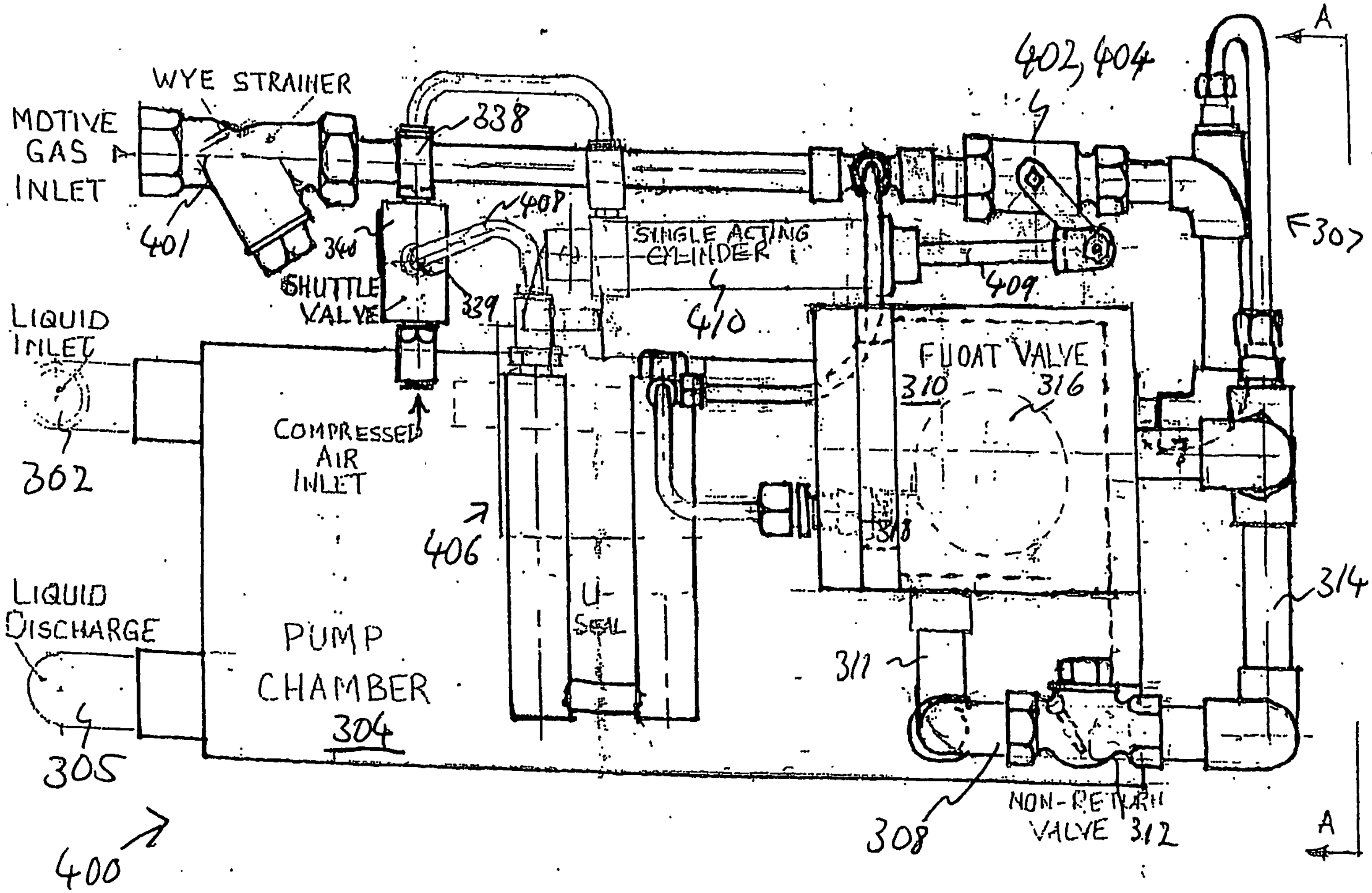
WYE STRAINER
MOTIVE GAS INLET
401
338
408
340
SHUTTLE VALVE
339
SINGLE ACTING CYLINDER
410
402, 404
409
307
A
LIQUID INLET
302
COMPRESSED AIR INLET
406
FLOAT VALVE
310
316
318
314
LIQUID DISCHARGE
305
PUMP CHAMBER
304
U-SEAL
311
308
NON-RETURN VALVE 312
400

FIG.4

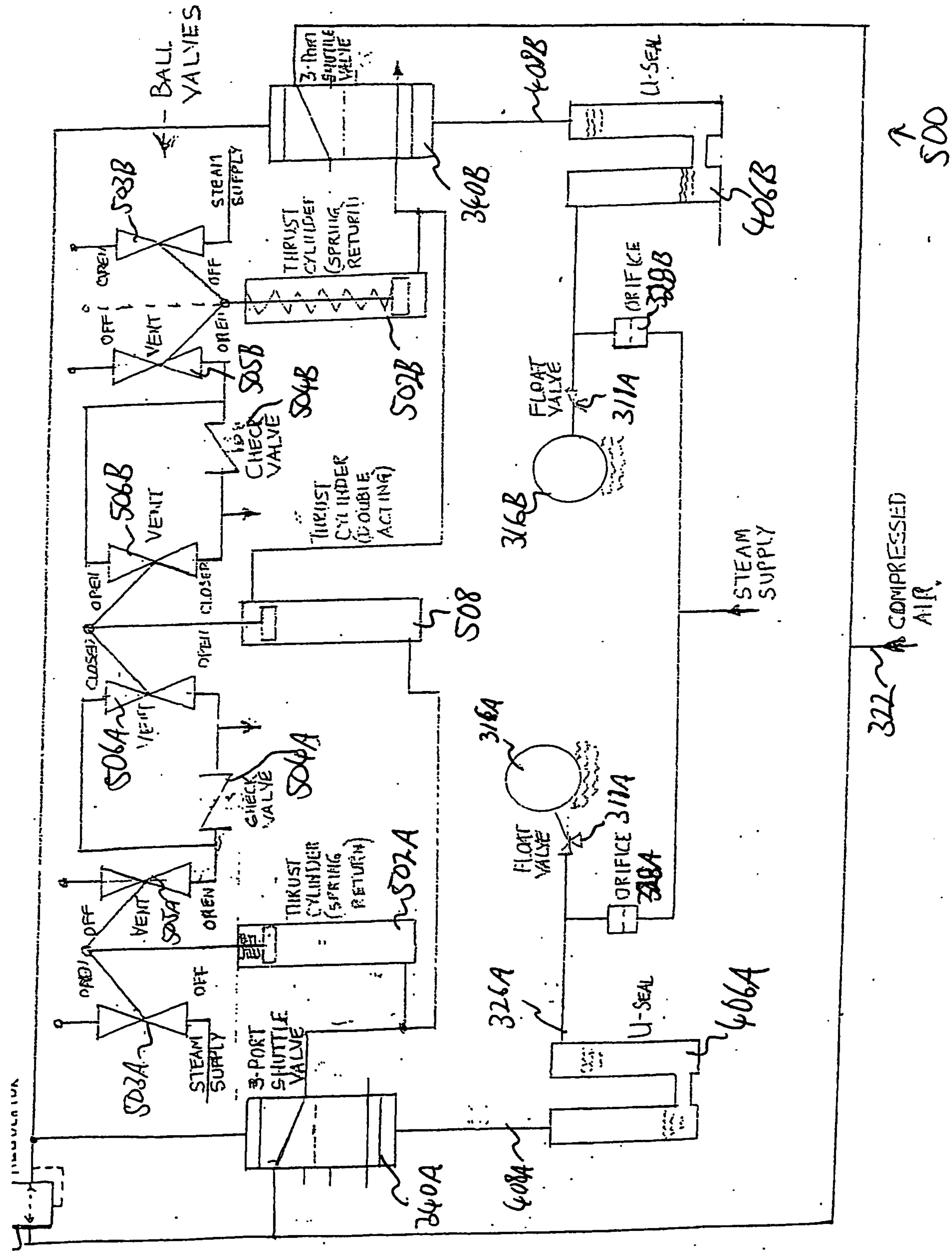
BALL VALVES
3-PORT SHUTTLE VALVE
U-SEAL
408B
360B
406B
500
STEAM SUPPLY
503B
OPEN
OFF
VENT
505B
THRUST CYLINDER (SPRING RETURN)
502B
ORIFICE
318B
CHECK VALVE
504B
FLOAT VALVE
311A
506B
THRUST CYLINDER (DOUBLE ACTING)
316B
CLOSED
508
STEAM SUPPLY
COMPRESSED AIR
322
506A
504A
316A
311A
502A
ORIFICE
318A
505A
503A
326A
406A
360A
408A

FIG. 5

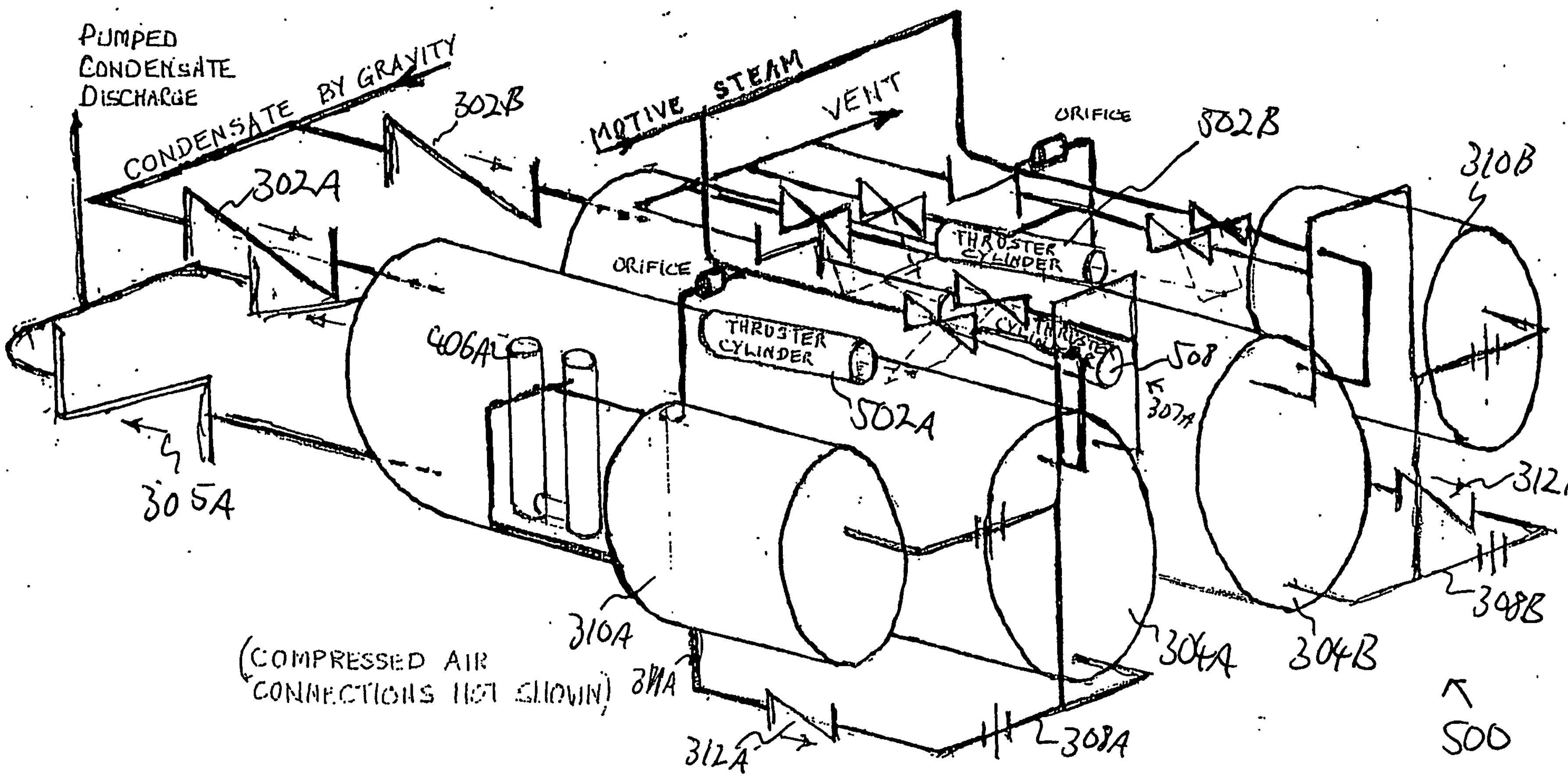
PUMPED CONDENSATE DISCHARGE
CONDENSATE BY GRAVITY
302B
302A
MOTIVE STEAM
VENT
ORIFICE
ORIFICE
302B
310B
THRUSTER CYLINDER
THRUSTER CYLINDER
THRUSTER CYLINDER
406A
502A
508
307A
305A
312B
308B
310A
304A
304B
(COMPRESSED AIR CONNECTIONS NOT SHOWN)
312A
308A
500

FIG. 6

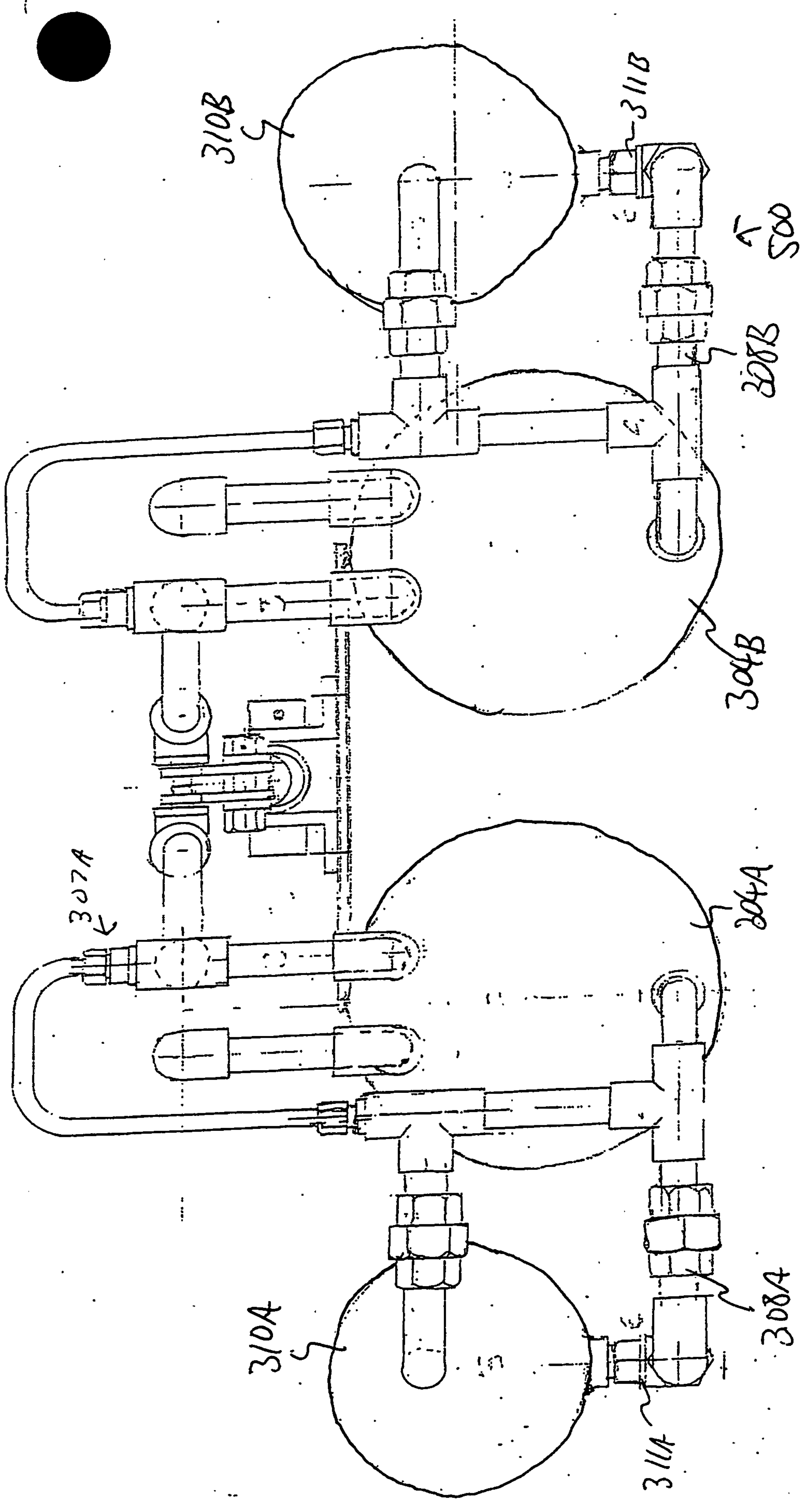

FIG. 7

Pump Apparatus

The present invention relates to pumps for liquids and in particular, although not exclusively, to pumps for steam condensate.

Pumps utilising chambers that may be allowed to fill by gravity to a chosen level and that are then pressurised using either the vapour of the liquid being pumped, or air (or sometimes an inert gas), to push the liquid from the chamber, are often described as "pressure-powered" pumps. The liquid enters and leaves the chamber through "non-return" or "check" valves. At the top of the chamber are two much smaller valves. The first one of these admits the pressurising or "motive" gas when it is open. The second one is a vent valve for releasing the motive gas from the chamber. The motive gas valve and the vent valve may be pneumatically actuated. In the case of one pattern presently used, the pneumatic signals to the valve actuators are controlled by electrical level probes in the chamber. Alternatively, the two valves may be actuated by electric motors, these again responding to electric level probes or level switches.

Other pressure-powered pumps in use at present, such as the pump 1 illustrated in Figure 1, have a relatively large float 2 carried on a lever arm 4 within the chamber 6. As the chamber fills with liquid, the buoyancy of the float 2 acting on the lever 4 applies force to one or more springs 8 which store energy as the float rises. At the upper tripping point the energy stored in the springs 8 is applied to a pushrod 10. This moves in such a manner as to close the vent valve 12 and to open the motive gas valve 14. The pressure in the chamber 6 then rises, closing the condensate inlet check valve 16, and at a sufficient value discharging the condensate through the outlet check valve 18.

As the condensate level in the chamber 6 falls, the float 2 is lowered, and its weight acting on the lever arm 4 again applies force to the springs 8. At the lower tripping point, the mechanism trips in the reverse manner and the energy

stored in the springs 8 is applied to the push rod 10 in the opposite direction, so as to close the motive steam valve 14 and open the vent valve 12. The chamber pressure then falls as the motive steam is released and the next cycle begins. During the "discharge" phase of the cycle, condensate cannot enter the chamber, so a receiver is needed to accept and store the condensate until it can flow into the chamber at the start of the next cycle.

Figure 2 shows an example of a pump 1 and an associated receiver 20 accepting condensate from a heat exchanger 22. The receiver 20 often is of a volume comparable to that of the chamber 6, and it is mounted at a height so as to permit gravity flow into the chamber at a desired rate. The drainage outlets 24 on the equipment from which the condensate is flowing must be at an even greater height to allow gravity drainage to the receiver 20 if the condensate is to flow when the source is at low or atmospheric pressure.

Condensate flow from the receiver 20 to the pump chamber 6 is intermittent, so the pipe sizes used often must be greater than those needed for continuous flow. Equally, flow in the delivery pipe 26 from the pump 1 occurs only during the discharge phase, so the instantaneous flow rate is higher than the average rate. Often increased pipe sizes are needed, compared with those that would be adequate with continuous flow.

Such existing pumps can be effective but have several drawbacks. First, they are inherently intermittent in action, requiring over-sizing of associated pipe work. Second, the pump chamber must be sufficiently tall to provide enough movement of the float, which also needs to be large itself, so that enough operating power is obtained to open and close the motive steam and venting valves against the pressures being used. Furthermore, the receiver must be at a sufficient height to allow gravity drainage to the pump chamber, and so steam-using equipment and steam traps often must be higher still. This can increase

the costs involved in mounting the steam-using equipment at sufficient elevation or, where equipment is already installed, may preclude drainage to the pump of condensate.

Another disadvantage associated with existing pumps is that the operating power of the mechanism is stored in one or more springs that are highly stressed. The springs are compressed or extended and released twice during each cycle of the pump, and are subjected to the severe conditions that exist within the operating chamber of the pump, Any replacement of a failed spring can only be effected after removal of the mechanism from the pump chamber. Similarly, removal of the mechanism from the pump chamber is needed before any maintenance work needed on other parts of the mechanism can be performed, or re-adjustment of the settings of the tripping levels. If any electrically operated probes, controllers or motors are used then these require special protection in locations that are dirty, steamy, or where inflammable vapours may be present.

According to a first aspect of the present invention there is provided pump apparatus including:

a first container having an inlet and an outlet, the chamber being pressurisable to effect discharge through the outlet;

a control apparatus for causing periodic pressurisation and depressurisation of the chamber in response to the level of liquid in the container,

wherein the control apparatus includes a pilot valve located in a second container connected to receive liquid from the first container when the level of liquid in the first container reaches a predetermined level, the pilot valve being configured to trigger a pressurisation/depressurisation cycle in response to the liquid level in the second container.

The outlet will normally include a non-return valve. During pressurisation motive gas enters the container, thereby causing the pressure of the liquid to exceed the outlet valve threshold. A shuttle valve may be used to allow the motive gas to enter or be vented from the container.

The second container can be relatively small compared with the first container. The second container may have its base at a relatively higher location than the base of the first container. The first and second containers may be linked by a pipe or line having a non-return valve.

The apparatus may further include a compressed air supply. The compressed air may be used as the motive gas. In an alternative embodiment, steam is used as the motive gas. In one embodiment, the compressed air is supplied to or vented from one or more thruster cylinder which operates to supply or vent steam (or any other suitable gas or vapour) for pressurisation/depressurisation of the container.

The pump apparatus may include two pumps substantially as described above, the apparatus further including a further valve component connected to a line for venting the motive gas from the containers of each pump, the further valve configured to open the venting valve of one pump when the venting valve of the other pump is closed.

According to a second aspect of invention there is provided pumping apparatus including two pumps, each said pump respectively including:

a first container having an inlet and an outlet, the chamber being pressurisable to effect discharge through the outlet;

a control apparatus for causing periodic pressurisation and depressurisation of the chamber in response to the level of liquid in the container; the apparatus being arranged so that when one said pump is discharging liquid, the other pump is receiving liquid through its inlet.

Pumps according to the invention can be suitable for pumping liquids that may be unsuitable for pumping by the use of centrifugal or other rotating pumps, or may be used in locations where electrically powered or controlled pumps would be undesirable or hazardous.

Whilst the invention has been described above, it extends to any inventive combination of the features set out above or in the following description.

The invention may be performed in various ways, and, by way of example only, embodiments thereof will now be described, reference being made to the accompanying drawings, in which:-

Figure 1 is a side view of a conventional pressure-powered pump;

Figure 2 illustrates schematically the pump of Figure 1 being used to pump heat exchanger condensate;

Figure 3 is a side view of a first embodiment of a pump according to the present invention;

Figure 4 is side view of a second embodiment where steam or condensate is used as the motive gas;

Figure 5 illustrates schematically a third embodiment having a duplex arrangement;

Figure 6 is a schematic perspective view of the pump of Figure 5, and

Figure 7 is a cross-sectional view through line A - A' of Figure 5.

Figure 3 shows an embodiment of the pump 300 where compressed air is used as the motive gas. The liquid to be pumped flows from a receiver tank (not shown) through a high-level non-return valve 302 into a chamber 304. The valve 302 is located near the top of the chamber 304. In the embodiment of Figure 3 the chamber is also connected to a second non-return valve 305 by a pipe that is located near the base of the chamber 304.

In the alternative embodiment shown in Figure 3A a "dip" pipe 305A passes through the top of the chamber 304 to near the bottom of the chamber, the valve 305 being located above the top of the chamber. This arrangement allows the liquid level in the chamber 304 to fall to a lower level than in the embodiment of Figure 3.

Returning to Figure 3, the valve 305 is intended to act as an outlet. A vent pipe arrangement 307 is connected to the upper portion of the chamber 304 which is intended to allow gas in the chamber to be vented as liquid enters. The chamber 304 is connected to a substantially horizontal pipe 308 (of ½" or 15mm nominal size) fitted with a non-return valve 312. The valve 312 can be of the swing check pattern or another type opening to a similar head of liquid. A vertical pipe 314 leads from the pipe 308 to a pilot valve chamber 310 which is relatively small compared with the main pump chamber 304. The chamber 310 contains a small float 316 attached to a valve 318. A pipe 311 leads from the base of chamber 310 to the pipe 308.

A compressed air supply 320 is connected to a line 322 having a T-junction 324. One branch of the junction leads down to a line 326 connected to the valve 318. The line 326 incorporates an orifice restrictor 328 having a pass area much less than that of the valve 318. The pressure may be at least 2/3 to 1 bar below supply pressure when the float valve 318 is open (an orifice diameter of 2 mm through which a split pin is fitted can function satisfactorily).

The other branch of the junction 324 leads to a line 330 that is fitted with a T-junction 332. One branch 334 of the junction 332 passes through a small pressure regulator valve 336 to one port 338 of a three-port shuttle valve 340. The opposing port 339 is connected to a part of the pipe 326 below the orifice fitting 328. The pilot port 338 is subjected to an air pressure that is maintained by the regulator valve 336 at a level around ½ bar less than the maximum

pressure at the port 339. The valve 340 is connected to the chamber 304 and can switch between a first position where gas in the chamber can pass out through a vent 306 and a second position where compressed air can enter the chamber via a second branch 342 of the T-junction 332.

Operation of the pump 300 will now be described. The liquid to be pumped flows through the high-level non-return valve 302 into the chamber 304. At this point air in the chamber 304 can be displaced through the vent line 306. Liquid in the chamber is allowed to flow through the horizontal pipe 308 towards the pilot valve chamber 310. The liquid cannot pass in this direction through the non-return valve 312. When the liquid in the chamber 304 has reached a sufficiently high level it can overflow through the vertical pipe 314 into the chamber 310. The liquid surface area within chamber 310 is much less than that in chamber 304 and so the rate at which chamber 310 fills is very rapid compared with the slower progressive filling of chamber 304. When the liquid level in the chamber 310 is sufficiently high the float 316 is moved to open the valve 318. Air from line 326 then flows into the pilot valve chamber 310 and the main pump chamber 304. Thus, the pressure in pipe 326 is lowered, causing the shuttle valve 340 to change over and apply motive air.

The liquid is discharged from low level in chamber 304 through the delivery non-return valve 305. The liquid levels in both chambers 304 and 310 fall. Liquid passes from chamber 310 via pipe 311 and check valve 312 into chamber 304. Due to the slight resistance to flow of the valve 312, the liquid level in chamber 310 remains about 2 inches or 50mm above that in the main chamber 304. When the level reaches a sufficiently low level in the chamber 304 the valve 318 closes. This causes the pressure in pipe 326 to rise rapidly to its maximum value, and the shuttle valve 340 changes position, venting the

chambers 304 and 310. This completes one cycle of the pump, which can then begin to refill.

In steam/condensate applications, the use of steam as the motive gas is often desirable, and a pump arrangement 400 such as that shown in Figure 4 may be applicable. Parts substantially similar to those of the embodiment of Figure 3 are given identical reference numerals and will not be described in detail again. Motive steam passes through a Wye strainer 401 and is admitted to the chamber 304 through a quarter-turn ball valve 402. The valve can be as small as ¼" or 7.5mm nominal size for condensate loads of up to about 5000 Litres per hour. A vent valve 404 is a similar ball valve of ½" or 15mm nominal size. The operating levers 409 of the valves are turned by the action of one or more pneumatic "thruster" cylinders 410 that are supplied with compressed air, or are vented, through a shuttle valve 340 substantially as previously described.

U-seals 406 are built into the pipe work so that steam cannot reach the shuttle valve pilot ports 338, 339. The seals can sense the pressure of air trapped in a pipe 408 leading to the shuttle port 339.

The operating levers 409 of the two ¼-turn ball valves 402, 404 may be linked together and operated by a single thruster 410, or each may have its own thruster. Addition of an extra vent valve, as described below, enables a duplex arrangement to be adopted.

Figures 5 to 7 show diagrammatically such a duplex arrangement in a pump arrangement 500. Again, substantially similar parts are given the same reference numerals as in the earlier embodiments. The pump 500 includes two chambers 304A, 304B, each chamber having its own associated components labelled with a suffix A or B. Each chamber has its own thruster cylinder 502. Preferably, the cylinder 502 is of the single acting, spring return pattern,

although a double-acting cylinder could be used. Each cylinder 502 operates a motive steam valve 503 and an initial venting valve 505. Each cylinder 502 has a respective controlling shuttle valve 340, each responding to the pressure in pipe 326 substantially as described previously. The initial venting valve on each chamber discharges through a non-return valve 504. This offers a slight resistance to flow, by the weight of the valve disc. Alternatively, the disc may be spring-loaded.

An extra vent valve 506 is fitted in a bypass around each non-return valve 504. Both valves 506A, 506B for both of the chambers 304A, 304B are operated by one double-acting thruster 508. The valves are arranged so that if either valve is closed, then the other valve is opened to complete the venting of its respective chamber. Each end of the thruster 508 is supplied with air at the same time as the respective thruster 502 that opens the steam supply valve on one of the pumping chambers. When one chamber has filled with condensate, its float pilot valve 318 is opened and the pressure in its pipe 326 is lowered. The shuttle valve 340 admits air to the thruster 502 and moves the steam valve to "open" and the initial vent valve 506 to "closed". The double-acting thruster cylinder 508 closes the vent valve 506 on this chamber and opens the vent valve 506 on the second chamber. The second chamber can then fill.

When the contents of the first chamber 304A have been pumped down to the "empty" level, the float pilot valve 318A closes. Pressure in the pipe 326A increases, changing the position of the shuttle valve 340A. The valve 340A vents the thruster 502A which closes the steam inlet valve 503A, and opens the initial vent valve 505A. Air is vented also from thruster 508, but the piston does not move, as both ends of the cylinder are now vented. The two vent valves 506A, 506B remain closed and open, respectively, and the first chamber 304A retains sufficient pressure so that its inlet check valve 504A remains

closed. Only when the second chamber 304B has filled does its pilot float valve 318B open, so that its steam valve 503B can open. Its vent valve 505B closes and the vent valve 506A of the first chamber 304A opens. The first chamber can then refill, as the second chamber is pumped out.

Each of the chambers effectively acts as a receiver tank to accept condensate when the other chamber is discharging. The two chambers 304 are thus allowed to fill and discharge alternately, making the flow of condensate to the pump virtually continuous, and discharge of the condensate into the delivery pipe may be more nearly continuous than when a single chamber is used. As no receiver tank located above the pump is needed, the apparatus requires less height than conventional arrangements. Further, the pump chamber need not usually contain any moving parts and so required minimal maintenance.

When the pressure of the motive steam is reasonably constant, the pressure of the air supplied to the pilot port of the shuttle valve opposite to the one sensing the conditions in pipe 326 is set by adjustment of the control spring of a standard pressure-regulating valve 511. Alternatives that could be used if the steam pressure is subject to variations in a particular installation include:

a) replacing the adjustment spring of the regulator with a pressure tight housing, and connecting the steam pressure to this. A light return spring below the diaphragm would be chosen so that the valve controlled the air pressure to about ½ bar below the steam pressure.

b) Using an extended pilot valve cover on that end of the shuttle valve connected to pipe 326 to allow the use of a small spring, to bias this end of the shuttle by the equivalent of ½ bar pressure. Instead of using an air pressure

regulator, the pressure of the steam supply is applied through a U-seal to the opposing pilot.

Pressure-powered pumps of any type presently available, having large internal float mechanisms with springs to store energy, or using level switches or probes to control motorised valves, will each accept liquid from a large receiver mounted above them. To obtain sufficient pumping capacity to deal with larger loads, two of these pumps may be used in parallel, with a common receiver above them. The system including duplex pumps described above can be adapted to obviate the need for the receiver and to provide a somewhat lower profile unit. The vent, or exhaust line, from each pump can be simply fitted with a line size check valve having a spring-loaded valve disc. Each check valve can have a bypass pipe in which a ball valve is fitted. The two ball valves are operated by a common double-acting thruster cylinder as described above. This is supplied with compressed air through a 5-port shuttle valve, and the two pilot ports of the shuttle valve are each connected to points below the minimum water level in the respective pumps.

When the motive steam valve on either pump chamber is open, the pressure on the liquid is then sensed at the 5-port shuttle valve. This changes position and the thruster opens the ball valve in the vent line of the other pump. The two pumps then operate alternately, and one chamber is always available to accept liquid while the other pump is emptying.

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